WIRELESS POWER TRANSFER FOR ELECTRIC VEHICLES

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Dedicated to

My Beloved Parents,

Zainuddin Bin Mah Jilis and Rohaya Binti Alias,

My supportive supervisor,

Dr Norihan Binti Abdul Hamid

My lovely siblings,

My friends who have encouraged, guided and

inspired me throughout my education journey

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ABSTRACT

This project is a development of a new approach to charging battery for electric vehicles using the inductive resonance coupling method. Inductive resonance coupling is a combination of inductive coupling and resonance frequency produced by the alternator. The aim of this project is focused on producing suitable power of the receiver coil to charge electric vehicle's battery. This project is start through designed and simulation circuit testing, then the data are collected and analyzed. The device is develop and presented in prototype. The performance of the charging device is analyzed. The demonstration of electric car prototype can be charged wirelessly using receiver coil placed under the car and the transmitter coil on the surface on the ground. However, the prototype are not able to charge the battery of electric vehicle but power produced are able to charge any low voltage electronic device such as a smartphone and rechargeable battery.

ABSTRAK

Projek ini memperkenalkan pendekatan baharu untuk mengecas bateri kenderaan elektrik dengan menggunakan kaedah gandingan resonans induktif. Gandingan resonans induktif adalah gabungan antara gandingan induktif dan frekuensi resonans yang dihasilkan oleh alternator. Matlamat projek ini difokuskan untuk menghasilkan kuasa yang sesuai untuk mengecas bateri kenderaan elektrik menggunakan teknologi tanpa wayar. Projek ini bermula melalui percubaan rekaan litar simulasi dan hasil dapatan kajian ini dikumpul dan dianalisa. Peranti yang dihasilkan dan dipersembahkan dalam bentuk prototaip. Kemudian, prestasi peranti pengecasan ini dianalisa. Demonstrasi prototaip kenderaan elektrik yang menggunakan pengecasan tanpa wayar dengan menggunakan gegelung penerima dipasang di bawah kereta dan gegelung penerima di atas permukaan jalan. Walaupun prototaip ini tidak mampu untuk mengecas kenderaan elektrik sebenar, kuasa yang dipindahkan mampu untuk mengecas peranti bervoltan rendah seperti telefon pintar dan bateri dicas semula.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Electricity is a necessity of today modern life. It is difficult to live or passing a day without electricity. Today, wireless power transfer has been attracting a great deal of attention. Wireless power transfer is the transmission of electrical energy from a power source to an electrical load without interconnecting wires. It is used to power on the electrical devices without the wire. Besides, because of this wireless power, some of the devices will not require the battery to operate.

There is a demand for wireless power transfer system. Nowadays, the development of wireless charging for smartphone is rapidly increase in market. The drawbacks of the system is the smartphone are need to attach charging plate but cannot lift it while charging.

In this project, the proposed wireless power transfer technique based on inductive resonance coupling method. When AC power has been supplied through a coil, magnetic field will be generated around the coil. At the moment, if another coil put aside it, induced current will produced and caused the magnetic field will also appear around the other coil. This is the reason that wireless power transfer is set up between two coils. Energy will be transfer when both coils will have same resonant frequency.

Many of the contactless feed systems are based on the electromagnetic induction's principle. Small distance wireless power transfer is demonstrated through used of induction. Knowledge of electric circuit logic and electromagnetic theory is important to realize the practical design. Knowledge of electric circuit logic and electromagnetic theory is important to realize the practical design.

This project provides a literature review of several wireless power transfer principle. All the methods that have been used to design wireless power transfer will be reviewed along with advantage and disadvantage of each principle. This project will conclude a discussion to choose suitable principle to charge electric vehicle.

1.2 Problem Statement

Current technologies only allow electric vehicles to be charged through plug-in cable. However, the problem occurs when the user need to find the charging point and the charging cable is lost or damaged. This project is about designing a wireless power transfer for electric vehicles. The concept of this project is suitable for any electric vehicles such as bus, car and light train. It will prepare a new convenient way to recharge the battery of the electric vehicles rather than using the traditional plug-in cable.

With the implementation of wireless power transfer (WPT) in order to charge the electric vehicle, there is no physical connection or contact between the vehicles and the power supply. The process is fully automated, whereby no human handling works are required to perform the charging process. Even though wireless power transfer concept is well developed and has been applied in industrial application, but its applications in the transport sector are still emerging.

Furthermore, another serious problem occurred with current plug in cable for electric vehicles is people tend to get an electrical shock if the cable system is damaged. With wireless charging approach for electric vehicle can prevent this incident happen because no wire or cable is required and it's transfer in electromagnetic form, so that, people will not get electrical shock in this kind of energy transfer.

Figure 1.1: Example of electric car using plug in cable

1.3 Objectives

The objectives of this project is:

- To study and investigate on wireless power transfer. A technique used in my research is an inductive resonance coupling method.
- To identify how many power (voltage and current) could transmit from primary coil (source) to a secondary coil (load).
- To design the wireless power transfer for electric vehicles by using the concept of inductive resonance coupling method. To prove it, a prototype will be built.

1.4 Scope of project

This research focus on developing a new approach of electrical charging using wireless power transfer.

- Study about wireless power transmission using the inductive resonance coupling method.
- Implement the receiver and transmission circuit simulation into the prototype.
- Develop the electric vehicles wireless power transfer devices.
- Develop the charging indicator using LCD display.
- Analyze the prototype through functionality measurement and testing.

1.5 Thesis Outline

This outline is divided into five chapters to provide reader to understand the whole project. It is organized as follows:

Chapter 1, *Introduction*, covers the overview of the project.

Chapter 2, *Literature Review and Background Studies*, all the project theory, perspective, methods that used to solve problem and any hypothesis that related in order to design the appropriate circuit.

Chapter 3, *Research Methodology*, the proper procedure in designing and manufacturing of the system is presented.

Chapter 4, *Result and Discussion*, the result of all experiments is presented. The experimental result is discussed and analyzed for future improvement.

Chapter 6, *Conclusions and Recommendations*, the conclusions of the experimental result is drawn and future work is recommended.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter encompasses the study of existing research related to the project. Every information extracted will be analyzed to enhance the understanding of the main concept all the way through this project. There are three principle used in wireless power transfer which is microwave, laser and inductive resonance coupling principle. The fundamental of these method are analyzed and compared in terms of performance. The suitable principle will be chosen to design wireless charging for electric vehicle.

2.2 Wireless Power Transfer Principle

The wireless power transfer is a technology of no wire included in terms of transfer the energy. Concept of wireless power transfer has been discovered widely since Nikola Tesla carried out his first experiment about pursuing his idea on wireless lighting and electrical distribution after successfully invent an alternating current [1]. They are many methods used in the wireless power transfer which are microwave, laser, and inductive resonance coupling method.

2.2.1 Microwave Principle

Wireless power transfer by using microwave method has been used more than a century [1]. It is called as microwave because the characteristics itself which is shorter wavelength of electromagnetic radiation in microwave range. The limitation of the wavelength radio is difficult to tune and overall efficiency would be too low for practical use [1]. The signal transmitted by microwave method will be received by rectenna. Rectenna is a combination of rectifier and antenna is used to convert the microwave energy back into electricity. The first rectenna is developed by W. Brown, the pioneer in wireless power transfer technology in 196.The concept of microwave method is explained with block diagram shown in figure below [5].